Appendix B

CRITICAL TIP MACH NUMBER—M^*_m

m	$\sigma=0$	$\sigma=\frac{1}{4}$	$\sigma=\frac{1}{2}$	$\sigma=\frac{3}{4}$
1	1.84	1.64	1.35	1.15
2	1.53	1.50	1.34	1.15
4	1.33	1.33	1.29	1.14
8	1.21	1.21	1.20	1.14
16	1.13	1.13	1.13	1.12
32	1.08	1.08	1.08	1.08

σ=hub tip ratio=$\frac{\text{Blade Tip Radius}}{\text{Blade Root Radius}}$

We claim:

1. In an axial flow compressor located within a fluid flow confining duct and which develops noise creating spinning modes due to interaction between stator vanes and rotor blades, the method of reducing the strength of the noise creating spinning modes comprising positioning a fixed stator within the duct which stator has a preselected number of stationary vanes around the periphery thereof, supporting a rotor for rotation within the duct which rotor has a prescribed number of blades around the periphery thereof and with the blades of the rotor being of different number from the vanes of the stator thereby developing noise creating spinning modes due to interaction between the stationary vanes and the rotating blades, and positioning the rotor to about five chord lengths from the stator to reduce the strength of the interaction between spinning modes so developed as to reduce the noise.

2. In an axial flow compressor comprising a rotor mounted for rotation within a fluid flow confining duct and having a stator adjacent thereto, the method of eliminating noise formed by spinning modes due to the interaction between blades carried by the rotor and stationary vanes carried by the stator on the rotation of said rotor, the method comprising selecting a rotor having a fixed number of blades threon, selecting a stator having a fixed number of vanes thereon that is different in number from that of the blades of the rotor, rotating said rotor to produce the aforesaid spinning modes, retracting said stator vanes from the fluid flow confining duct whereby at least one spinning mode due to the interaction between rotor blades and stator vanes is eliminated and the noise from the aforesaid interaction is reduced.

3. In an axial flow compressor within a fluid flow confining duct, the method of reducing compressor inlet noise of fundamental blade passage frequency and noise harmonics up to and including the noise harmonic of index n created by noise creating spinning modes formed by compressor rotor-stator interaction comprising selecting the number of stator vanes and rotor blades according to the formula:

$$V \geqslant 2nB$$

where V=number of vanes, B=number of blades and n=noise harmonic index, thereby producing spinning modes which decay rapidly.

4. In rotating blade-vane machinery within a fluid flow confining duct where maximum rotor tip Mach number encountered is ⅓ or less, in particular greater than

$$\frac{1}{2n+1}$$

and equal to or less than

$$\frac{1}{2n-1}$$

the method of selecting blade-vane combinations according to the formula:

$$B(1+M_B) \leq V \leq \frac{n}{n-1}B(1-M_B)$$

such that all components of blade passage noise up to and including that of noise harmonic index n decay,

where V equals the number of vanes, B equals the number of blades, n equals the noise harmonic index, and M_B equals the blade tip Mach number.

5. In an axial flow compressor located within a fluid flow confining duct, the method of reducing noise created by spinning modes formed by rotor-stator interaction by producing noise creating spinning modes which decay rapidly comprising selecting the number of stator vanes V and rotor blades B to produce a noise creating spinning mode with m-lobes so that the least number in absolute value of m, given by equation $m=nB+kV$, also satisfies $m \geqslant nBM_B/M^*_m$, where n equals the noise harmonic index, k is an index that ranges independently for all positive and negative integers, M_B is the rotor tip Mach number, and M^*_m is the critical or cutoff Mach number for the m-lobe pattern.

6. An axial flow compressor within a fluid flow confining duct having an axis, a rotor with blades about the periphery thereof mounted for rotation within said duct, a stator axially upstream of said rotor and having a number of substantially flat stationary vanes about the periphery thereof and with the number of vanes in said stator being different from the number of blades in said rotor and being sufficient in number to form noise creating spinning modes due to blade and vane interaction, said vanes extending radially inwardly from said duct for a part blade span while presenting a leading edge which extends inwardly and downstream and forms an acute angle with the duct axis to cause the noise creating spinning modes to decay.

7. In an axial flow compressor within a fluid flow confining duct having an axis and which develops noise creating spinning modes of particular frequency and lobe number m due to interaction between blades and vanes, the method of cancelling noise creating spinning modes comprising positioning a pair of axially spaced, equal vaned stators within the duct, mounting a bladed rotor for rotation between the stators and selecting the blade number to be different from the vane number to produce a first noise creating spinning mode due to interaction of the rotor blades and the first of the pair of stators and a second noise creating spinning mode due to interaction of the rotor blades and the second of the pair of stators, and positioning the rotor with respect to each stator so that the spinning modes will be of equal intensity, frequency and lobe number m and opposite phase to cancel each other.

8. The method according to claim 7 wherein noise creating spinning modes of identical frequency and lobe number from two separate blade-vane interactions are caused to cancel by altering the axial spacing between the interactions.

9. The method as in claim 7 wherein noise creating spinning modes of identical frequency and lobe number from two separate blade-vane interactions are caused to cancel by circumferentially indexing an element of the first interaction with respect to an element of the second interaction.

10. The method according to claim 7 wherein said cancellation is caused by altering the axial spacing and circumferential relative positions between an element of the first interaction with respect to an element of the second interaction.

11. The method according to claim 7 wherein the number of lobes m are equal to or greater than eight.

12. In an axial flow compressor located within a fluid flow confining duct and which produces noise creating spinning modes due to interaction between blades and vanes, the method of reducing ground exposure duration to noise radiated from the inlet of the axial flow compressor comprising mounting a stator with fixed vanes about the periphery thereof within said duct, mounting a rotor adjacent the stator within said duct for rotation, which rotor has a plurality of blades positioned about the periphery thereof which coact with the stationary vanes